

Teaching and Learning in Project Maths: *Insights from Teachers who Participated in PISA 2012*

Summary Brochure

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Full report and electronic version of this brochure are available on www.erc.ie/pisa

This brochure contains a summary of a recent report of a survey of teachers' experiences of and opinions on Project Maths. The survey was carried out in conjunction with the 2012 cycle of PISA (Programme for International Student Assessment). The report was published in advance of the release of the international data for PISA 2012. When these data become available, it will be possible to examine the impact of Project Maths on student achievement.

PISA 2012 in Ireland: A National Survey of Mathematics Teachers

PISA, the Programme for International Student Assessment, is an OECD study that takes place every three years. First implemented in 2000, it examines the reading, mathematics and science knowledge and skills of students who are aged 15. The assessment of these three domains is not limited to curriculum material, since the aim of the study is to examine knowledge and skills that are relevant to students' current and future lives in a broad sense.

Although all three areas are assessed every three years, one of the three receives particular focus in each PISA cycle as follows: 2000 reading, 2003 mathematics, 2006 science, 2009 reading, and 2012 mathematics. In addition to gathering information on achievement using a pencil-and-paper assessment, PISA 2012 included computer-based assessments of mathematics, reading and problem-solving.

PISA also collects background information through student and school questionnaires, in order to contextualise differences in achievement both within individual countries, as well as across the 67 participating countries.

In Ireland only, a questionnaire was administered to all teachers of mathematics in participating schools; the mathematics co-ordinator (or mathematics department head) in each school was also invited to complete a questionnaire. In total, 1,321 teacher questionnaires and 171 mathematics co-ordinator questionnaires were completed: these represent nationally representative samples, and response rates of 80% and 93% respectively. All initial Project

Maths schools participated in PISA 2012, allowing us to compare results in initial and other schools.

What Has PISA Told Us About Mathematics Achievement in Ireland?

The performance of Irish students on PISA mathematics may be characterised as disappointing. In 2000, 2003 and 2006, the mean mathematics score for Ireland was about the same as the OECD average score. Irish students performed comparatively better on the reading and science parts of the PISA assessment than on mathematics.

When the PISA 2009 results were published in December 2010, there was considerable media commentary about the fact that the Irish average reading and mathematics scores had declined significantly since 2006. Although mathematics achievement did not decline to the same extent as reading, it was disappointing that Irish students performed significantly below the OECD average in 2009. When the distribution of achievement for 2009 was compared with the distribution for 2003, it was found that the decline in achievement was more pronounced among higher achievers. These results suggest that students as a whole, and high achievers in particular, were not performing to their full potential in PISA.

The PISA results are consistent with other national sources of information on mathematics standards (e.g. Inspectors' reports, national assessments of mathematics in primary level), which indicated that many students were working with mathematics at a basic, mechanical level, and had difficulties with problems presented in 'unrehearsed' contexts.

Project Maths: Overview, Issues and Challenges

Project Maths was implemented initially in 24 representative schools in September 2008. It is a major curriculum reform initiative, in that it aims to achieve changes not only to the mathematical content of the syllabi for junior and senior cycles, but also the manner in which mathematics is taught and learned. An investigative, constructivist approach to teaching and learning underpins the initiative. Beginning the initiative in a small number of schools was intended to represent a 'ground-up' approach, where curriculum materials and teaching approaches could be developed and refined on the basis of the experiences in these schools.

At the time of PISA 2012 (March), Project Maths had not been fully implemented in schools, and a majority of students who took part in PISA 2012 would not have studied under the new curriculum.

The complete revised syllabi, which cover the five strands of statistics and probability, trigonometry and geometry, number, algebra, and functions, will not be examined until 2014 at Leaving Certificate level, and 2015 for the Junior Certificate. Changes to the syllabi are being made on a phased basis, so at around the time of PISA 2012, the first two strands were examined for the first time at Leaving Certificate level (June 2012), and these will not be examined in the Junior Certificate until June 2013. It will be 2017 before a cohort of students has experienced all strands of Project Maths from First Year all the way through to Sixth Year.

There has been quite a lot of media commentary on Project Maths. This commentary has tended to focus on a perceived 'dumbing down' of the curriculum, the mathematics required for some third-level courses, and the pressure put on teachers. There has not been much research on the implementation or the outcomes Project Maths so far, but teachers have been surveyed in two earlier studies, and time pressures experienced by them have come up as a significant issue in both. Other issues raised included difficulties in implementing the revised syllabi at the same time in both junior and senior cycles, lack of choice on the examination papers, and lack of availability of suitable textbooks. However, many teachers were positive about the initiative as a whole, despite these challenges.

Results from the PISA 2012 Teacher Survey

Teacher Qualifications and Continuing Professional Development (CPD)

We estimate that between 68% and 85% of mathematics teachers surveyed were qualified to teach mathematics according to Teaching Council guidelines. There was incomplete information on one-sixth of teachers, though most of these had completed some third-level studies in mathematics.

However, regardless of their initial teacher qualifications, over one-third of teachers surveyed felt that their initial education/qualifications had not prepared them adequately in the areas of mathematical content and assessment of mathematics.

Mathematics teachers have taken part in a significant amount of CPD relating to Project Maths: on average, they reported spending 45 hours on CPD over the three years preceding the survey. The majority of these hours covered CPD on Project Maths (20 hours) and self-directed CPD (14 hours).

Ability Grouping and Syllabus Level Uptake

Teachers in the survey tended to be in favour of ability grouping (streaming into different classes) for teaching mathematics, yet they also indicated awareness that ability grouping may not be equally beneficial for all students (and may have a negative effect on low achievers in particular).

Ability grouping for mathematics was very prevalent in the schools in the study, exceeding 90% at Third, Fifth and Sixth Year levels. Teachers' views on ability grouping varied depending on their school's own grouping practices, suggesting that school-level policies on grouping can shape teachers' views, or vice versa. The high prevalence of ability grouping probably stems from system-level factors, such as the assessment and certification of students.

Our survey recorded dramatic decreases in the percentages of students studying mathematics at Higher level as they progressed from junior to senior cycle, from 49% in Third Year, to 32% in Fifth Year, and just 20% in Sixth Year. The decline between Fifth and Sixth Years indicates that many students begin senior cycle studying mathematics at Higher level, but end up taking a less challenging level in Sixth year.

Teaching Activities

Our survey showed that, despite high rates of support for constructivist teaching approaches, teachers were more likely to use ‘traditional’ teaching methods and sources to guide their classroom activities. This may well be related to the structure of the examinations system and the manner in which the mathematics syllabus levels are interpreted and delivered.

Just three in ten mathematics teachers were classified as high users of ICT, in that they reported frequent use of laptops, data projectors, and both general and mathematics software during junior cycle mathematics classes.

Views on Project Maths

Teachers were asked the extent to which they agreed with the statement that ‘Overall, Project Maths is having a positive impact on students’ learning of mathematics’. Almost half of teachers (48%) responded that they did not know, which indicates that it may be too early for teachers to have a fully formed opinion on the initiative. More teachers agreed (30%) than disagreed (23%), however.

Teachers had generally positive views on the websites at www.projectmaths.ie and www.ncca.ie/projectmaths, the Common Introductory Course, the Bridging Framework, and the professional development workshops. They also reported using a greater range of resources in class, and that students had to do more ‘thinking’ in class. They were less positive about the phased implementation of Project Maths, and the clarity of learning outcomes. Teachers were unsure about parents’ and students’ views on Project Maths.

Teachers in our survey were of the opinion that there had been positive changes in a number of

aspects of students’ learning; in particular, understanding of key concepts in statistics and probability, and in geometry and trigonometry, level of awareness of the relevance of mathematics to other disciplines, ability to solve real-life problems, and ability to work collaboratively.

Significant challenges identified by teachers included the time available (both inside and outside of mathematics classes), the phased implementation and rate of implementation of the initiative, and the literacy demands of the revised syllabi.

Emerging Differences in Initial Project Maths and Other Schools

Although it is too early to make any definitive conclusions, four differences between the responses of teachers in initial Project Maths schools and other schools in our survey are worth noting:

- First, perhaps surprisingly, teachers in initial schools were more inclined to disagree with statements that parents and students welcomed the new approach.
- Second, teachers in initial schools perceived significantly greater improvements in some aspects of students’ learning, including ability to work collaboratively, explain how they solved problems, try different strategies, and grasp of fundamental concepts and principles.
- Third, almost twice as many teachers in initial schools (24%) compared with other schools (13%) reported that they placed a high emphasis on engaging students in small-group learning activities during junior cycle mathematics classes.
- Fourth, use of ICTs, particularly use of general and mathematics software during junior cycle mathematics classes, was higher among teachers in initial schools than in other schools.

Defining Mathematical Literacy

PISA describes mathematical literacy as *an individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make well-founded judgements and decisions...*

The objectives of the revised Junior Certificate mathematics refer to key aspects of mathematical literacy including *the recall of basic facts, instrumental understanding (knowing how to perform mathematical procedures), relational understanding (knowing why), and the ability to apply knowledge and skills in a range of contexts...*

In order to attain the objectives of Junior Certificate mathematics, students need both basic mathematical literacy skills (e.g., a good understanding of fundamental concepts, procedures, and mathematical vocabulary) and higher level skills (e.g., the ability to reason mathematically, and to use and apply mathematical concepts and procedures) and these need to be developed in tandem, drawing on a range of mathematical and real-world contexts.

Summary of Recommendations

The full report contains a set of 15 recommendations. Key ones are:

1. In line with the *National Strategy to Improve Literacy and Numeracy among Young People*, **increases in the amount of instructional time for mathematics should be accompanied by strategies** that incorporate teaching mathematical literacy to students who need it.
2. There needs to be a **better balance between ability grouping** for mathematics classes and the strategic use of **mixed-ability teaching** approaches.
3. **Students should receive encouragement** from junior cycle onwards **to achieve their potential in mathematics**, and **schools should** develop a policy to **promote take-up of Higher Level mathematics** in senior cycle that includes active encouragement and support for students in Fifth Year.
4. **Future CPD** opportunities should cover **mathematics teaching methods, assessment for and of mathematics, and mathematical literacy**.
5. The **use of ICTs** in teaching mathematics should be examined with a view to identifying **tools and strategies that are most effective** in achieving teaching and learning goals.
6. **Parents need to be better informed about Project Maths**, have an opportunity to voice their opinions on it, and receive encouragement to play an active role in their children's mathematics education. **Schools should encourage and facilitate parental involvement in their children's mathematics education**.
7. **The DES should review** the provision of **guidance and materials for mathematics** specifically as they relate to **students with lower levels of reading literacy**.
8. **The NCCA/DES should further clarify how the resources available** to teachers and students **may be used** with one another and in conjunction with textbook resources.
9. **The Junior and Leaving Certificate mathematics examinations should be reviewed in light of the implementation** of all five syllabus strands, and, to ensure continued consistency in standards, ongoing **comparisons between examination performance and standardised measures of mathematics achievement**, including PISA mathematics, **should be made**. This review process will need to be modified with the implementation of the new framework for junior cycle.
10. The **DES should** develop a strategy to **mobilise and utilise support from the third-level education sector** in order to further develop the aims and objectives of Project Maths.

Further information on PISA

First international results on PISA 2012 will be published in December 2013. They will include achievement results in mathematics, reading and science, and comparisons of mathematics achievement in 2003 and 2012. They will also include achievement results on computer-based tests of mathematics, reading and problem-solving. Background information from education systems, schools and students will be used to contextualise achievement, including how contexts may have changed over time.

National PISA website: www.erc.ie/pisa

OECD's PISA website: www.pisa.oecd.org

Queries on PISA in Ireland: email pisa2012@erc.ie; phone 01 837 3789